# REPORT ON THE REVIEW OF METALS IN CANNED FOODS

## Introduction

1. In October 1979 we were asked to review Metals in Canned Foods and to consider the influence of changes in can-making technology on the presence of metals in canned foods. In carrying out this task we have taken account of information obtained by the Working Party on the Monitoring of Foodstuffs for Heavy Metals and of representations received as a result of the announcement of our Review. A list of those who made representations or gave us help is at Appendix I.

2. We asked the Committee on the Toxicity of Chemicals in Food, Consumer Products and the Environment (COT) to advise on possible risks to health arising from metals in canned foods. We accept the recommendations in their report which is at Appendix II. We have also considered the latest report on lead from the Steering Group on Food Surveillance (a).

## Background

3. In our Report on the Review of the Lead in Food Regulations 1961 (b) we recommended that the statutory limits for lead in canned foods be lowered where we considered this was possible. In making this recommendation we recognised that the main obstacles in the path of further reductions in the limits for lead were the major changes in can-making technology necessary to bring about a reduction in the concentration of lead in canned foods. In its representations on our Report, industry provided evidence to demonstrate that the changes in can-making technology necessary to give effect to the reductions in statutory lead limits we had recommended, could not be achieved in the short term. We have now reviewed the situation again in the light of can-making technology as a whole and of changes in it since our Report was published. On this occasion, however, our Review embraces all metals with which foods are likely to be contaminated as a result of being canned.

## Scope of the Review

4. Our investigations have covered contamination from lead, tin, chromium, iron and aluminium in foods contained in open-top cans (cans whose lids are not replaceable) and general-line cans (cans whose lids are replaceable). We have considered all types of foods other than dried foods which do not cause dissolution of the metals in the body of the can. In practice, general-line cans are normally used for foods which do not dissolve metals to a significant extent.

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*(a)* The Steering Group's Tenth Report, 'Survey of Lead in Food: Second Supplementary Report' (HMSO 1983).

*(b)* The Committee's Report, 'Review of the Lead in Food Regulations 1961', FAC/REP/21 (HMSO 1975).

## Metals from Cans

5. There are three materials commonly used to make cans; tinplate, aluminium and tin-free-steel (TFS). The side seam on most tinplate cans is soldered with an alloy containing about 98% lead/2% tin, and on some cans the end seams are also soldered. The following metals may contaminate food contained in cans.

### *Lead*

6. There are two sources of lead in cans. The first and most significant source is the solder used in the fabrication of can seams. This solder often penetrates the seam, especially at the lap joints. During the soldering operation on the can body excess solder on the external surface of the can is wiped off by a rotating mop. This action generates particles of solder which may settle inside adjacent can bodies on the soldering part of the production line. The second source is lead contained in the tin coating on tinplate. British Standard BS3252:1960, currently requires that T2 grade tin, which in the UK is used in the production of electrolytic tinplate, should not contain more than 0.08% w/w [a] lead; in practice the lead content of these anodes and the tin coating on tinplate manufactured in the UK is generally much lower than this. We understand that BS3252:1960 is under review. Evidence submitted to us indicates that some of the lead in the tin coating is likely to dissolve into foods which are rich in malic acid – for example, plums and apples – but not into other foods. Even with foods rich in malic acid, the contribution of lead from tin coating to lead in the canned food is relatively small. Other impurities in the tin coating are present in minute concentrations but even if they dissolved into food with the tin they would cause negligible contamination.

### *Tin*

7. Most fresh foods contain very little tin, generally <10mg/kg [b] but food contained in tinplate cans, especially those cans having an unlacquered component, may attack tinplate causing dissolution of tin into the food. In the absence of cathode depolarisers (substances which may accelerate the corrosion of tin and other metals) the corrosion of tin by food is a very slow process. However, cathode depolarisers, such as oxygen and nitrate ions, may under suitable conditions accelerate the rate of dissolution of tin by more than an order of magnitude (that is, by more than a factor of

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[a] w/w = weight for weight

[b] mg = milligram, one thousandth part of a gram
kg = kilogram, one thousand grams
mg/kg = milligrams per kilogram

ten). Some oxygen is usually initially present in the can headspace after the can has been filled and sealed. Nitrate may be present in canned foods from ingredient water added to the food, from its natural presence in the food or from fertiliser usage.

*Chromium*

8. The tin coating on tinplate is usually given a 'passivation' treatment which results in a very light film of chromium and chromium (III) oxide being deposited onto the tin coating. This thin film generally contains no more than about 1 μg chromium/$cm^2$[(a)]. Some or all of the passivation film may dissolve into the food when the tin coating on tinplate is attacked. Tin-free-steel (TFS) is blackplate (the mild steel base of tinplate) coated directly with a passivation film, similar in composition to that on tinplate but about 10 times the thickness (13 μg chromium/$cm^2$). TFS is *invariably* lacquered when it is used in cans but a small amount of chromium might dissolve from TFS if the lacquer coating were damaged.

*Iron*

9. Under certain circumstances the mild steel base of tinplate and TFS may be exposed to the food contained in cans and the iron in the mild steel may dissolve into the food. This is especially likely when the lacquer coating used on TFS and, sometimes, on tinplate is damaged or particularly porous.

*Aluminium*

10. About 15% of cans for containing carbonated beverages are made wholly from aluminium; and in addition, most drink cans are fitted with an 'easy open' aluminium end. A very small proportion of canned foods, other than drink, are contained in aluminium cans. The internal surface of aluminium can bodies and ends is coated with a lacquer, and consequently dissolution of aluminium into canned food is unlikely unless the lacquer is damaged.

## Dietary Intake of Metals from Canned Food

11. Canned foods, excluding drink, account for about 6–7% w/w of the average UK diet. We have been provided with estimates of the contribution made by lead, tin, chromium, iron and aluminium in canned food to the total dietary intake of these metals. The available evidence indiates that even with a diet containing as much as 40% w/w of canned foods, intakes of aluminium and chromium are much the same as the intake from a diet containing no canned foods. On the other hand in the average diet canned foods provide at least 90% of the intake of tin, about 20% of the intake of lead and about 15% of the intake of iron. In a diet containing a greater

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*(a)* μg = microgram, one millionth part of a gram

than average proportion of canned foods these figures will obviously be increased. There is no information available on the absorption by man of metals from canned food and thus their contribution to the total body burden.

## Concentrations of Metals in Canned Food

12. Industry and the Working Party on the Monitoring of Foodstuffs for Heavy Metals have provided us with substantial data on the concentrations of metals in canned foods. The concentrations of aluminium and chromium in canned foods are much the same as they are in fresh food and this is reflected in the dietary intake of these metals from canned foods (paragraph 11). On the other hand the concentrations of tin, lead and, to a lesser extent, iron are often higher in canned foods than in the corresponding fresh food.

## Limits for Metals in Canned Food

### *Chromium and aluminium*

13. In the light of the information we have considered and the conclusions of the COT we see no useful purpose in having *specific* controls on the maximum concentrations of chromium and aluminium in canned foods. Accordingly we *recommend* that no limits should be imposed on the concentrations of chromium and aluminium in canned foods.

### *Iron*

14. There are no statutory limits or specific controls on the contamination of canned foods by iron. The concentrations of iron in canned food generally reflect those that occur naturally, although in some instances the concentrations have been increased by corrosion of steel in the can. Unlike lead and tin, iron is an essential element for man; indeed, there are recommended intakes of iron of 10 mg/day for men and 12 mg/day for women(a). We support the conclusion of the Committee on Toxicity that the iron content of canned foods in the United Kingdom does not constitute a potential hazard to health. Accordingly, we *recommend* that no limit should be imposed on the concentration of iron in canned foods.

### *Tin*

15. In 1952 the Metallic Contamination Sub-committee of the Food Standards Committee recommended(b) a limit of 250 mg/kg for tin in canned foods. Although this has not been incorporated in legislation it is used

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(a) Report by the Committee on Medical Aspects of Food Policy, 'Recommended daily amounts of food energy and nutrients for groups of people in the UK' (HMSO 1979).

(b) The Food Standards Committee Report on Tin in Canned Foods, FSC/MC/REP 9 (Ministry of Food, 1952).

as a guideline by the authorities charged with enforcing the Food and Drugs Act(a). Average concentrations of tin in canned foods are well below this figure, though a small proportion of cans contain tin in excess of 250 mg/kg. The COT has recommended that steps should be taken to reduce the likelihood of any canned foods having a tin content of 250 mg/kg or more. We are satisfied that, provided good manufacturing, storage and marketing practices are followed, it should be possible to ensure that canned foods on sale to the public do not contain more than 200 mg/kg in any item. We accordingly *recommend* that the guideline limit for tin in canned food should be reduced to 200 mg/kg, and that the new limit should be brought into effect from the same date as that adopted for the new statutory limits for lead in canned foods (paragraph 18).

*Lead*

16. With certain specific exemptions, the current statutory maximum limit for lead in canned foods is 2.0 mg/kg(b). Most samples of canned foods contain lead at concentrations well below the statutory limit, although a small proportion of canned foods contain lead in excess of the appropriate statutory limit. We have carefully considered what action, if any, we should recommend on lead in canned foods. The COT has said that it would welcome further efforts to provide the widest possible margin of safety in this area and it has recommended that the current levels of lead in canned foods should be further reduced as soon as this is technologically feasible. Most of the UK based can-makers have informed us of their intention to switch to the new can-making technology (Appendix III) and we welcome this and any action by the can-making and canning Industry which will minimise the contamination of canned foods by lead. As part of this Review we have considered the economic impact of changes in can-making technology. For example, one simple method of reducing lead contamination of canned food would be to replace the lead solder with pure tin solder; industry used this measure in the early 1970s to reduce lead contamination of canned infant food. Industry has said that it would be reluctant to use pure tin solder in place of lead on all conventional food cans since this would burden them with a heavy materials cost. The use of pure tin solder would cost UK industry about £10m–£15m each year depending upon the price of tin. In addition the use of pure tin solder would cause a substantial increase in the UK demand for tin.

17. A large proportion of the cans supplied for containing carbonated beverages are made using new can-making technology. Nevertheless, changes in can-making technology require extensive capital investment by Industry, both in the costs of the machines and in new buildings, as well as expenditure on modifications to existing plant. Even though a capital investment is required we understand that there are many advantages, often including savings in costs, accruing from the introduction of new can-making technology.

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(a) The Food and Drugs Act 1955. 4 Eliz.2. Ch.16. For convenience, reference is made throughout this Report to the legislation applying in England and Wales. In each case, separate but similar legislation exists for Scotland and Northern Ireland.

(b) The Lead in Food Regulations 1979. SI 1979 No. 1254.

18. We have also considered whether we can recommend lowering the statutory limits for lead in food. The shape of the distribution curve for lead levels means that a small proportion of canned food currently contains lead in excess of the statutory limits (generally 2.0 mg/kg, but with specified exceptions). We have therefore considered the possibility of recommending limits for lead based on the average of measurements made on several cans. Limits based on averages could be set substantially lower than the current maxima for individual cans given the smaller incidences of lead levels at the higher end of the scale, but this would merely be a cosmetic exercise because the actual concentrations of lead in canned foods would remain at the present level. Limits based on averages are not usual in UK law, and we believe that the consumer has the right to assume that each and every item of food purchased must comply with statutory requirements, and therefore our recommendations on lead limits continue to be based on maxima for individual cans. We see no reason why canned foods should contain more lead than the corresponding fresh food once the changes in can-making technology have been made and there is no longer a need to use lead to a significant extent in can manufacture. Accordingly we *recommend* that statutory limits for lead in canned foods should be brought into line with the limits for the corresponding foods not contained in cans; and where there is no corresponding food we *recommend* that the current general limit of 1.0 mg/kg should apply. Immediate introduction of the changes in lead limits would almost certainly cause sound foods to be removed from the market solely because they could not comply with the revised lead limit. While we think that a reduction in man's exposure to lead from canned foods is desirable and should be brought about as soon as practicable, we recognise that the can-making industry must be given a reasonable time to adopt the new technology required to comply with new standards. We therefore *recommend* that the new limits proposed above should be brought into effect not later than 1985.

19. We consider it important that the impact of forthcoming changes in can-making technology on the lead content of canned food should be determined. Therefore we *recommend* that the lead content of canned foods and the diet should continue to be regularly monitored. We wish to be informed of the results of this monitoring.

## Effect of Air on the Levels of Lead and Tin in Canned Foods

20. There is evidence to show that the presence of oxygen accelerates the dissolution of tin from tinplate and of lead from solder. It is often the practice to leave food that is surplus to requirements in the opened can, perhaps in a refrigerator, until required. This has the effect of providing a limitless supply of oxygen to accelerate the corrosion of tin and lead in the container, and can result in greatly enhanced levels of lead and tin in the food, and consequent increases in their intake. This does not apply to those foods sold in cans with resealable lids as, generally, these are used for types of foods which do not dissolve metals to a significant extent.

21. The Ministry of Agriculture, Fisheries and Food has, on our recommendation, already issued publicity warning against the storage of canned foods in the opened can, and we *recommend* that this publicity should be repeated at regular intervals. We endorse the recommendation of the COT that consideration should be given to the need for a warning against storing food in the opened can appearing on the label.

## Summary of Recommendations

22. We *recommend* that:

(a) no limits should be imposed on the concentrations of chromium, aluminium and iron in canned foods (paragraphs 13 and 14);

(b) the guideline limit for tin in canned food should be reduced to 200 mg/kg, with effect from the same date as that adopted for the new statutory limits recommended for lead in canned foods (paragraph 15, and sub-paragraph (c) below);

(c) the statutory limits for lead in canned foods should be brought into line with the limits for the corresponding foods not contained in cans; and where there is no corresponding food, the current general limit of 1.0 mg/kg should apply; these new limits should be brought into effect not later than 1985 (paragraph 18);

(d) the lead content of canned foods and the diet should continue to be regularly monitored so that the impact of forthcoming changes in can-making technology on the lead content of canned food can be determined (paragraph 19);

(e) publicity warning against the storage of canned foods in the opened can should be repeated at regular intervals; and consideration should be given to the need for label warnings against such storage (paragraph 21).

**FAC/REP/38** **1982**

# APPENDIX I

## List of those who made representations or gave information

Alcoa Manufacturing (GB) Ltd

Aluminium Federation Ltd

American Can (UK) Ltd

Association of Condensed Milk Manufacturers

Association of Public Analysts

Brewers' Society

British Steel Corporation

Campden Food Preservation Research Association

Carnation Foods Company Ltd

Chemical Society

Food and Drink Industries Council

Food and Manufacturers' Federation Inc

Fruit and Vegetable Canners Association

H J Heinz Company Ltd

Mardon Illingworth Ltd

Metal Box plc

Metal Packaging Manufacturers Association Ltd

Nacanco Ltd

Nestlé Company Ltd

Princes-Buitoni Ltd

Tate and Lyle plc Group

# APPENDIX II

## COMMITTEE ON THE TOXICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT

## REPORT ON THE REVIEW OF METALS IN CANNED FOOD

### Terms of Reference

To advise at the request of:

Ministry of Agriculture, Fisheries and Food
Department of the Environment
Department of Health and Social Security
Department of Trade
Health and Safety Executive
Medicines Commission, Section 4 Committees and the Licensing Authority
Committee on Medical Aspects of Food Policy
Home Office
Scottish Home and Health Department
Department of Agriculture and Fisheries for Scotland
Welsh Office
Department of Health and Social Services, Northern Ireland
Other Government Departments

1. To assess and advise on the toxic risk to man of substances which are:

    (a) used or proposed to be used as food additives, or used in such a way that they might contaminate food through their use or natural occurrence in agriculture, including horticulture and veterinary practice, or in the distribution, storage, preparation, processing or packaging of food;

    (b) used or proposed to be used or manufactured or produced in industry, agriculture, food storage or any other workplace;

    (c) used or proposed to be used as household goods or toilet goods and preparations;

    (d) used or proposed to be used as drugs, when advice is requested by the Medicines Commission, Section 4 Committees or the Licensing Authority;

    (e) used or proposed to be used or disposed of in such a way as to result in pollution of the environment.

2. To advise on important general principles or new scientific discoveries in connection with toxic risks, to co-ordinate with other bodies concerned with the assessment of toxic risks and to present recommendations for toxicity testing.

*Membership*

The following have served on the Committee during the preparation of this Report:

Professor P Turner, MD, BSc, FRCP, Hon MPS, Hon FI Biol (*Chairman*)
Professor F Beck, DSc, MD, ChB, LRCP, MRCS
Professor A E Bender, PhD, FRSH, FIFST
Professor B E Clayton, MD, PhD, FRCP, FRC Path
Professor D S Davies, PhD
J McL Philip, Esq, MRCVS, FI Biol
Professor D E Poswillo, DDSc, DSc, FRC Path, FI Biol
F J C Roe, Esq, DM, DSc, FRC Path
G R Tudhope, Esq, BSc, MD, FRCP, FRCPE
G N Volans, Esq, BSc, MD, MRCP
Professor O Wrong, DM, FRCP, FRCPE

*Joint Secretaries*

Professor F A Fairweather, QHP, MB, BS, FRC Path, FI Biol
B H MacGibbon, BA, BM, BCh, MRC Path
Mrs S J Hattersley, BSc
W H B Denner, Esq, PhD
M A Garley, Esq

*Assessors*

T J Coomes, Esq, BSc, FIFST
M J Griffiths, Esq

Representatives of the following Government Departments assisted the Committee with the preparation of this Report:

Department of Health and Social Security
Laboratory of the Government Chemist
Ministry of Agriculture, Fisheries and Food
Scottish Home and Health Department

## Introduction

1. We have been asked by the Food Additives and Contaminants Committee (FACC) to consider the *Review of Metals in Canned Foods*, and to advise on possible health hazards arising from current levels of lead, tin and iron in canned food. (The FACC had concluded that canned food is not an important source of dietary aluminium and chromium).

2. Data provided by Public Analysts (1978–1980) and the Ministry of Agriculture, Fisheries and Food (MAFF) (1981) have been used to calculate the mean concentrations (mg/kg) of lead, tin and iron in individual foods, or groups of foods presented as canned products. The *mean values* for lead and tin in all types of food tested were within the statutory or recommended limits. In addition, information is given in the review about the percentage of individual samples tested containing a particular concentration, within a range of levels, for each metal. Of all samples tested $< 5\%$ contained lead in excess of the various statutory limits (from 0.2 to 10 mg/kg), and 1.5% contained tin in excess of the recommended limit (250 mg/kg). There is no recommended or statutory limit for iron in canned food – and in general the amounts of iron found reflect its natural occurrence in food; fish and red fruits were exceptions, with levels (30 mg/kg) clearly in excess of the expected, indication that corrosion had occurred.

3. The significance of the data on the lead, tin, iron, aluminium and chromium content of canned foods for assessment of any potential hazard to human health must be considered in terms of possible acute and chronic toxicity, and also in relation to the availability for absorption of these metals when present in food.

## Acute Toxicity

### *Lead*

4. In adults, acute toxicity has occurred from the ingestion of 5–10 mg of lead daily for about one month, but the addition of 3 mg of lead (as the nitrate) to the normal dietary intake resulted in no overt toxicity although free erythrocyte protoporphyrin (FEP) levels were raised. The initial symptoms of lead toxicity (fatigue, anaemia, gastro-intestinal disturbance) may be followed by effects on the central nervous system. In children, the CNS effects may occur without premonitory symptoms or signs referable to other systems.

### *Tin*

5. In man reports of acute toxicity due to tin are related to the ingestion of canned products (especially acid fruit juices) with tin concentrations over about 250 mg/kg. The effects are mainly due to gastro-intestinal irritation. Symptoms developed in human volunteers following ingestion of fruit juice containing 342 mg of tin but those ingesting 125–182 mg were unaffected. In other experiments Benoy (1)[a] observed no toxicity with single doses of about 500 mg and Mamontova (2) found repeated daily doses of 200 mg to be without effect.

### *Iron*

6. Acute toxicity due to iron is mainly seen in young children following the ingestion of excessive quantities of medicinal iron preparations. Such children may develop vomiting, shock and metabolic acidosis following the ingestion of 0.5g of iron, and for a 2 year old child the average lethal dose may be 3g (3). For an adult, the lethal dose may be 14g. Systemic effects include liver and renal damage, and coagulation defects. Survivors may develop hepatic

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[a] Numbers in brackets refer to the table of References at the end of this Report.

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cirrhosis and pyloric stenosis. There is a variable response to the *medicinal dosages* in use; 100–200 mg daily of elemental iron may cause gastro-intestinal symptoms.

### *Aluminium and chromium*

7. Aluminium in the diet, in cooking utensils and in cooking foil has been a subject of intermittent concern since the 1920s but there is no evidence that these sources are harmful. Therapeutic dosages of aluminium compounds appear to have no direct toxicity in people with a normal renal function, although excessive loss of phosphate may occur. We noted the toxic effects that may occur when there are raised levels of aluminium in the water used for renal dialysis (11, 12). These effects are not seen when the aluminium is in drinking water, and they are not relevant to the study of aluminium in canned food. It has been stated that symptoms of excessive dietary intake of chromium are unknown (4).

## Chronic Toxicity

### *Lead*

8. Subject to the comments at paragraph 12, it can be said that the overall absorption of ingested lead is about 10% in adults and in infants may be as high as 50%. Some dietary studies have demonstrated a negative balance for lead although such studies in both children and adults have been of short duration. The principal excretory route for ingested lead is faecal, but much of this represents unabsorbed lead. Levels of urinary excretion of lead tend to follow levels of absorption but there is no precise relationship. Overt clinical chronic toxicity (as shown by lethargy, anaemia, gastro-intestinal symptoms, progressing to effects on the peripheral and central nervous systems, and in longstanding cases renal impairment) is generally related to a blood lead concentration (PbB) of 80 μg/dl [(a)] or more. Blood lead levels are considered to reflect recent exposure to lead (perhaps 6 weeks duration) and the Lawther Report (5) found no convincing evidence of harm at levels below 35 μg/dl. Indications of metabolic stress are a decreased activity of d-aminolaevulinic acid dehydratase (ALAD) which may be detected from levels of 5–10 μg/dl PbB, but is not thought to be harmful below 20 μg/dl; an increase in FEP, which may begin at 20–30 μg/dl PbB; and an increase in urinary ALA excretion. The significance for health of such reduced enzyme activity is debated; there is a possibility that substrate accumulation could be toxic. It has been estimated that in adults a daily increment of 100 μg of lead may increase the PbB by 1–7 μg/dl, depending on whether the baseline is 30 or 18 μg/dl. The response may be curvilinear. It has been calculated that ingestion of 2.3 or 3.3 mg/day of lead by an adult would result in a PbB of 80 μg/dl after 4 years or 8 months respectively. In young children, 1–2 mg/day may cause toxicity in 5 or 6 months. Ingestion of flakes of leaded paint is the most common cause of poisoning in children, the clinical pattern being one of acute-on-chronic toxicity.

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*(a)* dl = decilitre, one tenth of a litre

*Tin*

9. Ingested tin is poorly absorbed and chronic toxicity in humans has not been reported.

*Iron*

10. Under normal circumstances about 10% of dietary iron is absorbed, but this is very variable, being affected by a wide variety of influences that include the mucosal regulating mechanism and the presence of minerals, phytate, animal tissue and ascorbic acid. DHSS is aware of a single report that when dietary iron is provided solely by canned food, absorption may be increased (6). The long term ingestion of iron in an available form can result in iron overload. In those most commonly affected (Africans) faecal studies suggest that the effect may begin at 100 mg/day of iron. Alcoholics may also suffer iron overload but in them factors additional to high iron intake are suspected.

*Aluminium and chromium*

11. As reported in paragraph 7, aluminium and chromium at current levels in food do not cause any known toxicity.

## Availability for Absorption

*Lead*

12. The Lawther Report (5) concluded that in adults an average of 10% of dietary lead was available for absorption, but that in children a higher rate (40%) should be assumed. Recent work in the USA confirms this higher rate in children (7). There have been suggestions that the rates of absorption of lead may vary with the type of food; eg much of the lead which accumulates in offal (kidneys) is reported to be protein-bound and insoluble (8). The rate of absorption of lead from the gastro-intestinal tract has been found to vary with the composition of the diet. Milk enhances the absorption of lead as well as of calcium, this effect being strongly dependent on its content of lactose. Dietary factors known to influence lead absorption also include the levels of other minerals, particularly calcium, phosphorus and magnesium, the levels of vitamin D and phytate, the proportion of carbohydrate, fat and protein, and alcohol. The mechanisms by which these factors influence lead absorption are complex and in many cases poorly understood.

*Tin*

13. Tin is poorly absorbed from the intestinal tract; the WHO suggested that the rate is about 5%, although higher rates have been reported (9).

*Iron*

14. The absorption of iron is regulated by mucosal and luminal factors, and it appears that in developed countries iron balance is maintained by rates of about 6% and 12% for men and women respectively (3). There is a considerable variation in absorption rates for different foods, but in general iron in vegetables is poorly absorbed (1–10%) compared with that in meat (5–20%).

### *Aluminium and chromium*

15. Aluminium is poorly absorbed as is also the case with chromium except for that contained in the most available form, glucose tolerance factor (GTF) (10), which is a constituent of yeast.

## Comments

16. The present levels of lead and iron in canned food give no cause for concern in the context of acute toxic hazard. However, the ingestion of canned food (particularly fruit juices) containing the current recommended limit for tin (250 mg/kg), or above, has been associated with acute symptoms in human subjects. We noted that whereas the lead content of canned food demonstrates a plateau effect, the level of tin continues to rise with duration of shelf storage time. We accept that extension of the use of fully lacquered cans to reduce the level of tin in the contents would be unwise, because of the possible adverse effects from iron or lead dissolution.

17. There does not seem to be any report of chronic toxicity in humans resulting from the ingestion of inorganic tin. Therefore, although canned food provides 90 to 100% of the dietary intake of inorganic tin, there is no reason to be concerned about current levels of tin in canned foods on the basis of long-term health effects. Although the long-term ingestion of absorbable iron in daily amounts exceeding 50–100 mg can produce toxic effects, the amount of iron present in canned food does not present a toxicological problem. Our concern is with long-term effects of lead ingestion. This question can be considered from two standpoints – weekly intakes or blood levels of lead.

18. The FACC, in its *Review of the Lead in Food Regulations 1961* (15), provided an estimate of lead intake from food and beverages of 1.2 mg/week for the average adult consumer. The recent report of a Department of Health and Social Security Working Party on Lead in the Environment (5) quotes more recent total diet studies commissioned by MAFF which give an average weekly intake of the order of 0.8 mg for an adult. Allowing for differences in analytical technique there has probably been no significant change in weekly intake. These values are well within the provisional tolerable weekly intake of 3 mg, for an adult, suggested by the FAO/WHO Expert Committee on Food Additives (16), and would appear to indicate that lead levels in food, including canned food, do not constitute a problem.

19. However, the Council of the European Communities adopted a Directive (77/312/EEC) (17) that member states should assess the exposure of the population to lead, outside the working environment, based on the measurement of blood levels over a four year period. The acceptable upper level (to be exceeded by only 2% of the population studied) is 35 μg/dl. This level was chosen because of its association with a significant increase in urinary excretion of ALA which can be interpreted as a sub-clinical effect on health. The survey carried out in the United Kingdom in 1979/80 (13)

showed that some children, subject to additional exposure in their domestic environment, had blood levels above 35 μg/dl. There is continuing concern about the possible neurophysiological effects of low exposure to lead in children (5, 14), but no firm evidence on which to establish a safe level for blood lead concentration. In such a situation it can only be considered prudent to adopt measures to provide as wide a margin of safety as possible. While it cannot be suggested that the raised blood levels found in the survey resulted from ingestion of canned food containing undue amounts of lead, it must be borne in mind that for most of the population food constitutes the major source of exposure to lead, and canned food contributes 20 – 40% of the normal dietary intake of lead. In an atypical situation, with a diet containing an above average proportion (such as 10%) of canned food, the amount of lead ingested may be increased by 40 – 60%.

20. We would welcome more information about the absorption of lead derived from canned foods, and the factors which predispose towards the establishment of a state of negative balance for lead.

## Conclusions

21. Our conclusions are as follows:

(a) The iron content of canned foods in the United Kingdom does not constitute a potential hazard to human health.

(b) Although the mean tin concentrations in food examined were below the levels associated with acute toxic effects, the contents of a number of individual cans showed levels of tin exceeding 250 mg/kg, and must be considered to present a potential, though minor, hazard to human health.

(c) The aluminium and chromium contents of canned food are not greater than those in other food, and do not constitute a hazard to human health.

(d) In the general population of the United Kingdom the major source of lead intake is from food. Although present dietary levels of lead present no proven toxic hazard, it is difficult to identify levels of lead in the body and in the environment that all toxicologists will accept as completely without toxic potential. Canned food contributes 20–40% of the total dietary lead from a normal diet. Therefore, we feel it would be prudent to make every effort to ensure the widest possible margin of safety.

**Recommendations**

22. Accordingly, we recommend:

    (a) that steps should be taken to reduce the likelihood of any canned food having a tin content of 250 mg/kg or more; and that consideration should be given to the need for a warning against storing food in the opened can appearing on the label;

    (b) that the current levels of lead in canned foods should be further reduced as soon as this is technologically feasible;

    (c) and that, in the meantime, work should be carried out on factors (including general dietary factors) affecting the absorption of lead derived from food and particularly canned food.

March 1982

## REFERENCES

1. BENOY, C.J., HOOPER, P.A. and SCHNEIDER, R. (1971). The toxicity of tin in canned fruit juices and solid foods. Food Cosmet. Toxicol. 9, 645.
2. MAMONTOVA, A.A. (1940). Effects of tin on animal organisms. Vop. Pitan. 2, 13.
3. NATIONAL RESEARCH COUNCIL (1979). Iron, 127. University Park Press.
4. NATIONAL ACADEMY OF SCIENCES (1974). Chromium, 29. Washington DC.
5. Lead and Health (1980). HMSO.
6. CALLOWAY, D.H. and McMULLEN, J.J. (1966). Faecal excretion of iron and tin by men fed stored canned foods. Amer. J. Clin. Nutrition 18, 1.
7. Unpublished, cited at the Symposium on the Health Evaluation of Heavy Metals in Infant Formulae and Junior Foods, Berlin, November 1981.
8. GOYER, R.A. (1973). In: Heavy metals in the aquatic environment (ed. Krenkel, P.A.).
9. WORLD HEALTH ORGANISATION (1976). Environmental aspects of tin (draft).
10. NATIONAL ACADEMY OF SCIENCES (1974). Chromium, 35. Washington DC.
11. WARD, M.K., FEEST, T.G., ELLIS, H.A., PARKINSON, I.S. and KERR, D.N.S. (1978). Osteomalacic dialysis osteodystrophy: evidence for a water-borne aetiological agent, probably aluminium. Lancet i, 841.
12. EUROPEAN DIALYSIS AND TRANSPLANT ASSOCIATION (1980). Dialysis dementia in Europe. Lancet ii, 190.
13. Pollution Report No 10 (1981). HMSO.
14. YULE, W., LANDSOWN, R., MILLAR, I.B. and URBANOWICZ, M.A. (1981). The relationship between blood lead concentrations, intelligence and attainment in a school population: a pilot study. Dev. Med. Child Neurol. 23, 567.
15. FAC/REP/21 (1975). HMSO.
16. WORLD HEALTH ORGANISATION (1972). Evaluation of certain food additives and the contaminants mercury, lead and cadmium (WHO tech. rep. ser., No 505).
17. Official Journal of the European Communities No L 105 of 28.4.77.

## APPENDIX III

## NEW CAN-MAKING TECHNOLOGY

1. The way in which food cans are made influences the contamination of canned food by metals. Several methods of manufacture are now available which avoid the use of lead-containing solders.

### Traditional three-piece cans

2. The following alternatives to lead-containing solders are available for the manufacture of traditional three-piece cans:—

(a) *Pure tin solder* – infant foods, which were previously packed in cans made with pure tin solder, are now contained in two-piece drawn and redrawn (DRD) cans (see below). The existing can-making lines utilising pure tin solder are now used for the manufacture of small cans for speciality foods. It is estimated that the use of pure tin solder for all three-piece food cans (excluding cans for containing drink) would, in the UK, cost somewhere in the region of an additional £10m–£15m a year; the exact figure is obviously dependent on the price of tin.

(b) *Cemented side seams* – these seams are used for some general-line cans but do not yet have the strength or reliability required for open-top cans.

(c) *Welded side seams* – cans with welded seams may be produced in the same profusion of sizes and specifications as cans with soldered side seams; complete internal lacquering is optional but the internal face of the weld is always lacquered.

### Two-piece cans

3. There are two types of two-piece cans, drawn and wall-ironed (DWI) and drawn and redrawn (DRD):—

(a) *DWI cans* are produced by first forming a shallow cup from a disc of metal which is then fitted to a punch and forced through a die. The wall of the cup is squeezed between the punch and die. This wall-ironing process increases the depth of the cup considerably but at the expense of reducing the wall thickness. DWI cans are especially suitable for containing carbonated beverages and, when they are fabricated with strengthening beads, may be used for containing canned foods. DWI cans are invariably internally lacquered because the wall-ironing process violently disrupts the tin coating on the tinplate currently used in the fabrication of DWI cans.

(b) *DRD cans* are made by forming a shallow cup from a disc of metal (as for DWI) but then re-forming the cup to produce a deeper and narrower container. The process is not yet suitable for manufacturing cans with a large height/diameter ratio and, in general, the metal from which the can is formed needs to be lacquered.

4. The machinery for making two-piece cans is not flexible in its use and such cans are unlikely to be used for seasonal foods, such as soft fruit.

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